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ABSTRACT

A series of papers is presented from two symposia sponsored by the Work Environment and Technology Committee and offered at annual conferences of the President's Committee on Employment of People with Disabilities. The 1988 symposium was called "Applying Technology in the Work Environment" and the 1989 symposium was called "Reasonable Accommodation through Technology." The papers provide diverse perspectives on issues concerning application of technology to the needs of workers with disabilities. The papers include: "The Consumer's Role in Job Accommodation" (James A. Kutsch, Jr.); "Rehabilitation Counseling and Technology Assessment for Job Accommodations" (Reed Greenwood); "Universal Design and Office Accommodations" (Susan Carter and Diane Patry); "Federal Accessibility Policy: A Tool for Advancing Innovation" (Susan Brummel); "High-Tech Homework" (Donna Walters Kozberg); "Rehabilitation Engineering Applications for Low-Back Pain and Other Disabilities" (Gerald Weisman); "Employment Technology Programs for People with Disabilities: Case Studies of Successful Fund Raising Approaches" (N. Jeanne Argoff); and "Innovative Technology for People with Disabilities: What Can Be, What Is, and What Will Be" (Sam McFarland). (JDD)

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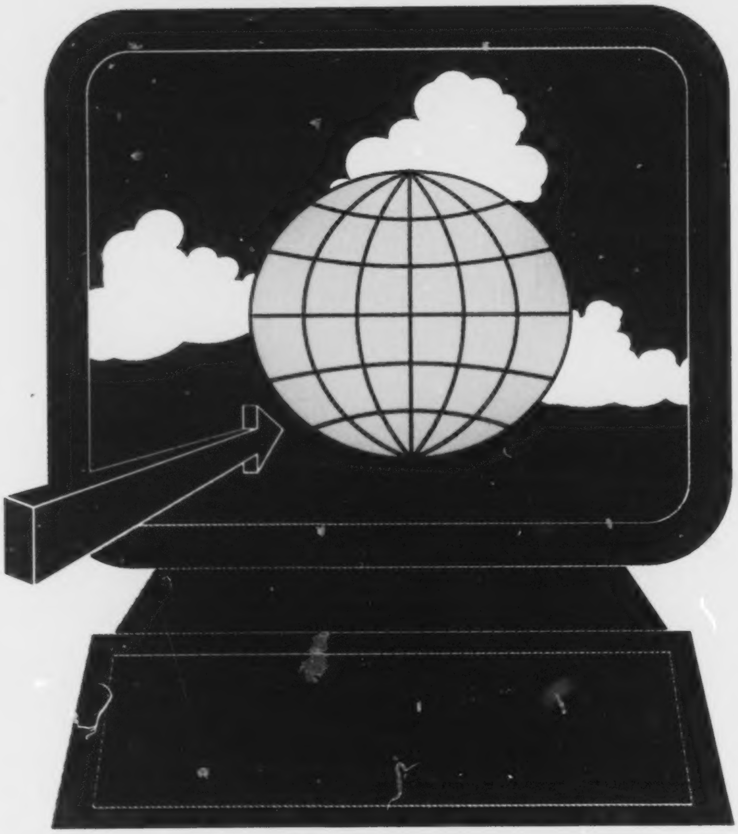

# Applying Technology
## in the work environment

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President's Committee on Employment of People With Disabilities
Arkansas Research and Training Center In Vocational Rehabilitation

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# Applying Technology
## in the work environment

Reed Greenwood, Editor

**President's Committee on Employment of People With Disabilities**
Work Environment and Technology Committee

**Arkansas Research and Training Center In Vocational Rehabilitation**
College of Education, University of Arkansas • Arkansas Division of Rehabilitation Services

AUGUST 1990

# Applying Technology in the Work Environment

The Work Environment and Technology Committee of the President's Committee on Employment of People with Disabilities dedicates this volume to Sam McFarland, who died on Monday, June 19, 1989. He was a hard working member of the committee and wrote one of the chapters of this volume.

His professional life was dedicated to the field of rehabilitation engineering and assistive technology. More importantly, he was committed to the idea that assistive technology, when appropriately applied, was ultimately an instrument to empower people with disabilities. This vision and commitment shaped Sam's approach in working to improve the delivery of services to people with disabilities. He was also involved in the Rehabilitaton Engineering Society of North America (RESNA) and other professional groups.

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# Foreword

**Justin Dart**

The revolutions of technology and individual rights are sweeping the world. This dynamic process holds the potential to eliminate most of the traditional barriers to the equality and productivity of people with disabilities. It is our responsibility and the purpose of "Applying Technology to the Work Environment" to ensure that this potential is fulfilled.

Justin Dart, Chair
President's Committee on Employment
of People with Disabilities

# Preface

**Reed Greenwood and Dale Brown**

The activities of the Work Environment and Technology Committee of the President's Committee on Employment of People with Disabilities result in many different outcomes. Originating from the Worksite Committee founded in 1983, the Committee promotes accommodation of people with disabilities in the workplace, with emphasis on technological solutions, and develops projects and programs to promote the employment of people with disabilities through improvements in the work environment. The Committee was chaired by Ruth Hall Lusher at the time the monograph was being written. Current Committee members represent the fields of architecture, computer access, education, industrial design, industrial engineering, interior design, human resources, public relations, rehabilitation counseling and rehabilitation engineering.

This publication includes a series of papers presented at two Annual Conferences of the President's Committee through symposia sponsored by the Work Environment and Technology Committee. The first, Applying Technology in the Work Environment, was a part of the 1988 Washington Conference. The second, Reasonable Accommodation through Technology, was conducted at the 1989 Conference held in Tampa. Since both symposia were well received, it was agreed that the presentations should be shared with a larger audience. As a result, this joint venture was conceived.

The papers provide interesting and diverse perspectives on a variety of issues of concern to those interested in the work environment and application of technology to the needs of workers with disabilities. Ranging from consumer involvement to funding mechanisms the papers draw attention to the importance of technology and the support systems required to make technology available to the consumer.

Obviously, new developments take place that cannot be recognized in the papers. However, we feel that any limitations associated with the time delays between the presentations and printing are readily compensated for by the continuing applicability of the papers to the needs of people with disabilities.

We must acknowledge those who made this monograph possible. First, our thanks to the authors for their excellent presentations and their willingness to translate the presentations into manuscripts. Next, we must recognize the sponsoring organizations--the continuing support of the President's Committee, especially Jay Rochlin, Executive Director during the creation of this monograph, and Justin Dart, Chair; and the Arkansas Research and Training Center in Vocational Rehabilitation at the University of Arkansas, for the assistance of Verrion Glenn, Director, and his willingness to support the monograph. Finally, our special thanks to the staff at the Center who made it possible: Mary Drevdahl, for the tape transcription, editing and management of the manuscript; Anita Owen, for the typing and preparation of the print copy for publication; and Lou Tabor for the art work and supervision of production.

We hope you enjoy and profit from these papers as much as we have, and that your enjoyment is translated into a tangible effort to improve work environments and make technology available to workers with disabilities.

Dale Brown
Washington, D.C.

Reed Greenwood
Fayetteville, AR

August, 1990

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The Consumer's Role in Job Accommodation

Rehabilitation Counseling and Technology Assessment for Job Accommodations

Universal Design and Office Accommodations

Federal Accessibility Policy: A Tool for Advancing Innovation

High-Tech Homework

Rehabilitation Engineering Applications for Low-Back Pain and Other Disabilities

Employment Technology Programs for People with Disabilities: Case Studies of Successful Fund Raising Approaches

Innovative Technology for People With Disabilities: What Can Be, What Is, and What Will Be

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# The Consumer's Role in Job Accommodation

James A. Kutsch, Jr.

Job accommodations should be done ***with*** an individual who has a disability, not ***for*** that individual! The difference in that single word describes a key difference in the relationship among the employee, the employer, and the rehabilitation engineer or accommodations specialist. All three parties must participate in the accommodation process. Each has valuable insight and information, and pooling the resources of all three from the beginning of the process contributes greatly to the ultimate success of a potential accommodation.

A personal example of how ***not*** to initiate the accommodation process dates back to my first year in college. Someone in the chemistry department saw my name on the class role and ***decided*** that a blind student could not take chemistry. I found out about this decision when my advisor informed me that I could not continue my major in electrical engineering since freshman chemistry was a required class. The part that bothered me the most was that no one in the chemistry department ever discussed ***with*** me how a blind person might function in a chemistry lab. As a humorous post script, it was particularly ironic because the cause of my blindness was an accidental chemistry explosion while in high school. So either the university chemistry department was very uninformed on disabilities and accommodations or they were very smart and did not want ***me*** back in a lab! In either case, I was never offered the opportunity to find out why I could not take the chemistry class.

Unfortunately, making decisions behind the scenes without consulting the employee is quite prevalent. Recently, I was consulted about a blind person who used a guide dog. His employer was considering him for a job in a machine shop with a very high noise level; however, the employer was very concerned about the guide dog in the high noise environment. Placement had been delayed for weeks while the employer attempted to investigate the possible effects of the noise on the dog. The employee, himself, had not been consulted, nor did he know what was holding up his job placement. Ironically, no one knew this particular dog better than the master! Of everyone, ***he*** was most qualified to resolve the issues; but he was never given the chance.

As a final example, a New Jersey employer was concerned about signaling alarms to a deaf employee who was a dark room technician. The fire alarm system had been modified in his office so when the alarm went off, special lights flashed. They could not use this technique in the dark room because it would destroy any of the dark room processes that were going on during real or false alarms and fire drills. There was great concern, many meetings with management, and many meetings with accommodations people on what to do. But, again, no one ever discussed the situation with the employee. When I was consulted, I pointed out that one of the ***first*** things they should do is consult the employee himself. They did. The employee immediately offered two solutions. One was the use of a vibrating pocket pager and the second "no-tech" solution was that he would work a buddy system with his friends in the department such that, if there were ever an emergency, someone would come into the dark room and tell him to get out. Simple solutions, but again the individual was not consulted during the process, or at least, not early enough.

Think of job accommodations of which you are aware. Note that each of these modifications is very individual. Each disability, each set of limitations is very specific to one individual. More importantly, the person's remaining abilities are extremely individual.

There are many obvious examples. A person with severe motor impairment might have limited control of certain muscles so a rehabilitation engineer chooses from lots of different kinds of switches: some that can be operated by fingers, sip and puff switches, eye blink detectors, etc. Everybody thinks the need to match the type of switch with the person's abilities is very obvious, but now let us apply the principle to other disabilities.

What about the remaining individual abilities of blind people? Some have enough residual sight to read large screen text. Some prefer to work with braille; others prefer to work in an auditory domain. I carry a pocket tape recorder to take notes; other blind people prefer to use a slate and stylus or a computer terminal. The point is that there are ***many*** individual strengths and weaknesses, as well as outright preferences, with ***each*** particular person.

Concerned employers of able-bodied people try to give each employee the best tools to do the job, whatever that job is. A good typist is given an electric typewriter with spelling checker and correction capability rather than an old mechanical typewriter. This is done to allow the employee to work to his or her full potential at peak efficiency. Similarly, an engineer doing circuit layout on a CAD-CAM system may require a large screen or color terminal and perhaps a controlled light environment to be productive. A disabled person is asking for the same consideration--tools that will allow maximum productivity and efficiency-- but in this case we call it job accommodation. Employers are very willing to spend thousands of dollars on those accommodations for able-bodied people. Accommodation devices for disabled people may look different and should be very unique to the individual using them, but the same principle applies: give workers the tools they need to do the job well!

Another problem disabled people face on the job is stereotyping. I have always said I would hate to be the ***second*** blind person hired in a particular company. The managers, subordinates, and co-workers all talk to the first blind person and, after a while, decide "Okay, we've got it, we know how blind people do things." No they do not! They know how that ***one*** person does things. That one person may be an anomaly in the population. An understanding of how disabled people do things cannot be based on a sample population size of one. It is not until there are three or four people with similar disabilities in a company that one starts to overcome this effect. The second person with the same disability is at an extreme disadvantage when entering a company.

In my undergraduate computer science classes, I had to design most of my own accommodations. I started by seeking the help of various younger students; offering some tutoring in return for reading my computer output. I quickly realized the need to have a more independent means of obtaining computer output. Using loud-sounding and quiet-sounding characters at appropriate times on a printing computer terminal, I designed a Morse Code output system. A simple solution, but probably one that another blind person would not find easy to use. This accommodation drew upon my strong skill with Morse Code (I had been a ham radio operator since early in high school), but to assume that ***all*** blind people could use Morse Code is a serious over-generalization.

Another problem that arises is that people sometimes solve the wrong problems. This usually occurs when well meaning managers or well meaning co-workers without a lot of training ask themselves "What would I need if I were blind? or deaf? or in a wheelchair?" Then someone gets a wheelchair somewhere and drives it around a building for a little while and believes that they now are a self-proclaimed expert on what it is like to be in a wheelchair. Or somebody wears a blindfold to work for a few hours and decides, "Okay I know the problems of a blind employee in this environment." In fact, such a person does solve ***some*** problems--the problems typically faced by a person who has become a wheelchair user or become blind in the last few hours. These are not the challenges faced by a person who has been trained to live with blindness or to live with a wheelchair.

For example, a few years ago elevators were marked with braille in the building in which I worked. The thought process might have gone like this: "***If I were blind***, I could not read the numbers on elevator buttons. If I were blind, I could read braille. Therefore, we should put braille labels on the buttons." So, in a three story building, they put the braille numbers 1, 2, and 3 on the three buttons inside each elevator. It was a great solution, but it was the ***wrong*** problem. The ***real*** problem is determining where you are when the doors open. That problem is not solved by braille labels on buttons inside the elevator. Braille outside the door, a bell when the elevator passes each floor, or voice synthesis solves the real issue. Here again, early consulting with the disabled employee would help focus accommodation efforts on solving the real problems.

A goal in any accommodation should be to make a general, portable accommodation. Disabled employees want a career, not just a job. They want the same opportunities for promotion, taking a lateral transfer to another part of the company, and even the same freedom to move from one company to another. Disabled people tend to feel locked in a particular company when that company has spent multiple thousands of dollars on modified equipment. If the employees later want to work for the company across the street, it can be difficult since all the equipment and all the modifications stay with the company. A disabled employee does not necessarily want to job shop more frequently than any other employee. Nevertheless, expensive, customized accommodations equipment is not a factor that able-bodied workers worry about when considering a job change.

Further, accommodations equipment can become a limiting factor in promotion or advancement. Typically, disabled employees start in entry level jobs, but have the same dreams and aspirations as their able-bodied co-workers. Suppose a blind person is hired as a switchboard operator in a mid-sized company. An appropriate accommodation is effected by purchasing a braille switchboard console and transcribing the company telephone directory into braille. After some months, this blind switchboard operator notes that most operators move on to positions as receptionist or secretary and this operator would like the same career path opportunities. Too many employers resist the advancement interest expressed by employees who have disabilities. The employers consider the need for additional accommodations for other positions within their company and some even believe the employee should be more "appreciative" of the entry level job. This leads to employee job dissatisfaction and poor performance. No one wants to work for many years, possibly until retirement, in an entry level position. Here again, considering an able-bodied employee for a particular job is free from the encumbering factors of accommodations equipment.

Generally, portable accommodations are the key to successfully offering ***careers*** to people with disabilities. The best solution results in something I can take home if I want to work at home; something I can use in the office; something that will go with me from one assignment to another in the company. In a computer access accommodation example, it is necessary to modify the terminal or computer equipment, not the application software for any particular assignment. If the choice is between putting a screen reader on a general purpose terminal or re-writing a program for entering service tickets, by all means make the computer system accessible so that, if the employee gets another job, he/she can use the same adapted equipment in the new assignment.

I have had some harsh words for employers and co-workers, now I am going to turn the guns on fellow disabled people. The disabled employee or prospective employee has some serious obligations in the accommodation process too. As noted earlier, it is a process to be done ***with*** the employee or prospective employee. The biggest obligation, the biggest responsibility that the disabled employee or prospective employee has is one of seeking accommodations for equality but not for privilege. It is very easy to inadvertently try to get a privilege. Doing so, deliberately or unintentionally, can damage the employer's, and more importantly, the co-workers' attitude toward people with disabilities.

I know of a disabled employee who had difficulty walking, especially through snow. As an accommodation, his company gave him a reserved parking space near the door. In general, only company executives had reserved spaces. The disabled employee said he appreciated the efforts, but demanded the ability to park anywhere in the lot and wanted a guarantee of adequate snow removal at all times. This was not a ***reasonable*** accommodation.

In another case, an undergraduate student who is blind who worked at a local community college told the faculty and the advisors of the college that blind people could not do math. He said there was no way to do it--braille was unsuited to math equations. When I became involved in the case, the student was well on his way to convincing the college to give him an exemption from all math requirements in the degree program. I stressed to the individual that he was being unethical. His behavior was very disadvantageous to the rest of us who are trying to get jobs with integrity. Eventually, had he gotten a degree, and subsequently a job, his credentials would have been inaccurate. He would not have had the ability to do the job because he would have lacked the math skills required to do that particular job. I recommended to the university that they adhere to the math requirements for the student, and that they give him a failing grade if that was indicative of his performance.

College is a great learning ground for able-bodied students; further for students with disabilities, it offers a unique opportunity to experiment with accommodations in a safe environment. It is an environment where the effects of failure are limited to possibly receiving a lower grade, or at worst, having to drop and retake a class. By contrast, learning in the job market places one much more at risk: the job itself, the annual raise, advancement, and the image you leave with the employers who may or may not hire disabled people into that job in the future.

Several factors contribute to the ultimate success of the accommodation process. The following questions might contribute to better accommodations:

- Was the employee actively part of the accommodation process through all phases of that process?
- Does special equipment take advantage of the employee's unique abilities?
- Was a simple, minimal cost solution found?
- Was the "right" problem solved?
- Is the solution portable and appropriate for other assignments within the company?
- Has an accessible career path been provided for the employee?
- Were all accommodations that the employee requested truly "reasonable"?

These points are not necessarily the only ones that should be considered during the accommodation process. But this view from the consumer's perspective will help the reader formulate some working guidelines for job accommodations.

# Rehabilitation Counseling and Technology Assessment for Job Accommodations

**Reed Greenwood**

The task of technology assessment for job accommodations is one which falls within the professional responsibilities of the rehabilitation counselor working with a team of other rehabilitation professionals including physicians, nurses, occupational and physical therapists, rehabilitation engineers, and other specialists. The rehabilitation counselor's work in job development and placement has been an area of research at the Arkansas Research and Training Center in Vocational Rehabilitation during the most recent five year programmatic research on employment for workers with disabilities. Specifically, this research has involved the design and testing of strategies to enhance the job development and placement skills of rehabilitation counselors and other placement practitioners. This presentation is a brief overview of major considerations facing the rehabilitation counselor in job accommodations, with specific emphasis on the assessment of technology for job accommodations.

The rehabilitation counselor has responsibility for facilitating both the functional assessment of the person who is preparing to enter the labor market and the assessment of labor market opportunities that will provide the optimal career development for the person. Functional assessment normally involves a complex array of personal factors including:

- aptitudes - ability to perform work tasks;
- interests - preferences for jobs and tasks;
- physical/cognitive abilities - meeting physical/cognitive demands of jobs and tasks;
- the work personality - work habits, motivation, and social skills related to work;
- general personality characteristics - underlying personality traits and their meaning for work;

- environmental considerations - strengths and limitations related to the physical environment; and
- job seeking skills - skills related to the job search process.

The counselor works with the person with a disability to determine the functional abilities of the person to relate to each of these areas in understanding career development and work-related skills and needs. Each area should be considered prior to the determination of any final career goals.

Technology has had the most impact on accommodations related to physical abilities and the physical work environment. The counselor should have sufficient skills to (a) evaluate or facilitate the evaluation of needs and skills in this area, and (b) translate the needs into information which can be used to guide technology assessment related to these areas.

In addition to the functional assessment process, a job analysis must be made covering the job tasks, task-related abilities, social ability requirements, and general requirements for successful performance. The job analysis covers essentially the same items as the functional assessment but addresses these from the job rather than the person perspective. Finally, a work environment analysis must be made to assess characteristics such as accessibility, temperature, humidity, presence of obstacles, fumes/odors, noise, indoor/outdoor setting, and other important environmental characteristics.

The process of job/person match follows the gathering of information about persons and jobs, and accommodations strategies play a significant role in the matching process. The counselor may also need to include technology assessment related to physical/cognitive abilities and the work environment, and perhaps other aspects of the person or the job.

At the Arkansas Research and Training Center in Vocational Rehabilitation we are developing an approach toward job accommodations which includes all of the factors above as well as the identification and assessment of technology which may facilitate job accommodations. The approach first involves the identification of assets and limitations the person may have in physical or cognitive abilities such as those associated with hearing loss; sitting, lifting, or back disorders; cognitive impairments or difficulty in interpreting information; ability to reach, handle, finger or feel; mobility impairments; and visual impairments. Such a general classification scheme allows the counselor to pinpoint specific functional assets and limitations which the individual has and which are required by consumer's perspective will help the reader formulate some working guidelines for job accommodations.

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The counselor uses an approach such as that advocated in a publication of the Work Environment and Technology Committee (Alexander & Greenwood, 1985). This publication identifies each major area of functioning and reviews specific problems and solutions related to the area. For example, the area of lifting and carrying identifies three major problems:

- objects to be lifted and/or carried are too heavy or bulky for the worker to handle;
- objects are located in places difficult for the worker to access; or
- frequency or duration of lifting/carrying task causes excessive fatigue. (Alexander & Greenwood, 1985, p. 41).

These problems are followed by suggested solutions including assistive devices such as overhead cranes, lifts, and carts. However, the solutions are only beginning considerations for accommodations and usually lead the counselor to explore other sources of technology.

Rehabilitation counselors are not engineers and most have very limited technical backgrounds. Therefore, it is important to provide them with the tools by which they can help workers with disabilities search for technological innovations for job accommodations. Several systems can be particularly helpful in searching for such technology.

### The Job Accommodations Network (JAN)

This system is operated by the Rehabilitation Research and Training Center at the University of West Virginia and supported by the President's Committee on Employment of People with Disabilities. This is perhaps the single most useful resource to counselors and employers in accessing accommodations information. JAN is a nationwide computerized network of information on accommodations employers have made to enable workers with disabilities to be employed or return to work. JAN uses a computer data base with human factors/rehabilitation engineering consultants who answer inquiries. The consultants translate the job accommodation needs, which are based on the functional assets and limitations of the person and a description of job tasks, into targeted job accommodation strategies. The consultants can access experts who assist with unusual or difficult problems. A toll free number (1-800-526-7234) is provided for inquiries. The person making the inquiry must provide information regarding the nature of the disability, the type of job involved, and the functional limitations to be accommodated.

### AbleData

This computer-based system is funded through a grant from the National Institute on Disability and Rehabilitation Research and contains a listing of more than 10,000 commercially available aids and devices for people with disabilities. Information on the products along with consumer and other evaluations is provided. Devices range from simple accommodations such as checkbook templates to eye switches which can be used to operate computers. Payment is required for custom searches.

### The International Directory of Job-Oriented Assistive Device Sources

This is one example of a directory of devices which has been developed to facilitate employment. The manual contains several hundred assistive devices indexed by job title, job functions, and disabilities. This is a very useful desk reference for specific information about job accommodations, many of which are technological devices specially designed for workers with disabilities. Each entry includes the job title or function, disability, problem, solution, a brief description, and the contact source for the dévice. Limited evaluative information is available on the items. (See references for information on this and other publications.)

### Accent on Living: Buyer's Guide

This special publication of the ***Accent on Living*** magazine provides useful information on over 400 products, many of which are technological aids for a variety of independent living and employment functions. A comprehensive index is provided listing the types of products available. However, limited information is provided on the products and no product evaluation data are provided.

### Veterans Administration: Rehabilitation R&D Progress Reports

This comprehensive document is published annually as a compilation of rehabilitation research and engineering in the U.S. and abroad. The publication contains a wide range of information on ongoing and completed research, including projects related to the development of technology for job accommodations. In addition to the publications, the Veterans Administration maintains the R&D Reports on the VA Rehabilitation Database which is available to over 300,000 system users. Annual reports are published in January of each year and are available through the Veterans Administration.

Therefore, the rehabilitation counselor and others working in the job accommodations area have access to considerable information. Unfortunately, limited evaluative information is available by which to judge the usefulness, durability, and other features of the technology. Counselors, as well as consumers, do not have ready sources of such evaluative information and must make decisions regarding the products through other users or through the product developers.

One system which can be of use to job developers involved in job accommodations is a computerized job matching procedure developed at the Arkansas Research and Training Center in Vocational Rehabilitation. This system was designed for use in vocational rehabilitation and community rehabilitation settings to facilitate job searches for specific workers with disabilities. Using IBM compatible floppy disks, RehabMatch provides for the input of information on the worker and jobs in formats which allow for searching by either worker or job vacancy. There is no data base other than what the local operator chooses to store in the computer. Therefore, each practitioner must gather the worker and job data and enter it in the system. RehabMatch includes information on the job title, job tasks, physical and mental abilities, social skills, the work environment, and related items. Designed as a user-friendly program, the system requires minimal instruction for the operator to become proficient in storing and accessing information.

Accessing job accommodations technology requires a comprehensive understanding of the job and the worker. Rehabilitation counselors and others interested in accommodations should systematically gather data about the functional abilities and limitations of the worker, job tasks and the work environment in order to access technology. The ability to identify functional limitations or specific problems which the individual worker has in relation to the job enables the counselor to access a variety of data bases and publications which can provide information about technology.

These were described briefly in this presentation along with information on accessing the sources. The author is aware of limited sources of evaluative information on such technology, and there is a need to develop systems which can provide such data to consumers and rehabilitation practitioners. Fortunately, the practice of rehabilitation engineering is becoming more widespread, and these practitioners can help in evaluating as well as engineering and developing the technology in this important area.

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# Universal Design and Office Accommodations

**Susan Carter and Diane Patry**

Universal design is a ***concept.*** It is the global, all-encompassing effort to remove any and all barriers from the environment; to create accessible, comfortable, responsive spaces for the largest possible population.

Universal design is a ***philosophy.*** It is a commitment to uncovering and resolving problems during the design development process, ensuring that the final plan meets the broadest spectrum of needs.

Universal design is ***common sense.*** It is the realization that all people have varying degrees of ability ... and disability. Universal design is the acknowledgement that we are imperfect beings living in an imperfect world.

Universal design is a ***method.*** It is a thoughtful, analytical approach to creative design solutions. Universal design accommodates us all.

Universal design principles produce the most accessible spaces both from a physical and nonphysical point of view because consideration is given to a broad spectrum of limitations, not only mobility, but sight, hearing, perceptions, strength, balance and stamina. Universal design benefits people with disabilities and those without disabilities simultaneously by focusing on wayfinding, safety and communication.

The elements of wayfinding and safety incorporate color, texture, contrast, light, touch, sound and perception of the path. In practice, wayfinding is the process of decoding or interpreting physical signals. Responses to colors are inherited, learned and geographic. From a technical point of view, color can also be affected by the quality of light available. Color can be used to effectively improve an overall office environment and as a signalling mechanism. Warm and cool colors need to be apportioned according to climate. The complexity of color schemes also varies with the climate, i.e., as more time is spent indoors, the color scheme must offer more variety. For all people, but especially for people with hearing limitations, color and light cues become crucial.

Repetition of colors or color coding, such as all conference room doors the same color, for example, is another form of cueing for people who are dependent upon their eyes and for people with low visual acuity. Contrast between colors can be used to effectively delineate something as large as architectural landmarks and something as small as message holders. Some contrast is necessary in order to be able to discern information on a printed page or a sign, but too much contrast can cause eye strain and headaches.

Differences in texture produce more indications of wayfinding. A person with little or no sight can feel and hear the changes in flooring when walking over carpet onto vinyl tile, while a person with little or no hearing can see the changes in flooring. Variety in wall and work station texture relieves monotony, eye strain, and can act as a tactile indicator for people who do not see well.

Lighting and the perception of time passing during working hours are two of the most difficult elements to control in an office environment. The presence of sunlight mitigates the effects of poor lighting and "cabin fever" on the one hand, at the same time causing heating, ventilating and air-conditioning problems. The creative use of lighting can encourage people to traverse long hallways, point out hazards, or destroy their ability to do their jobs. Lighting must, whenever possible, replicate natural light in color, be diffuse enough not to cause confusing shadowing, and should not cause glare or veiling reflections on surfaces and screens. Of late, various parabolic fixtures have been used to cure veiling reflections on computer screens and illuminate horizontal work surfaces. Vertical surfaces must be illuminated along with horizontal surfaces. This allows the eye to perceive the parameters of the space and allows a person to navigate.

Both touch and hearing indicators appear to be minor considerations in office environments, but to the contrary, they are critical information avenues for people who are limited by blindness or low vision. Raised lettering and braille signage along with audible indicators are often overlooked; however, they are an integral part of accommodation for everyone.

Safety egress is a function of quick and easy perception of the escape route. Confusion can cause injury. Signage and indicators must be immediately understood. For people with sight, color plays an important role in safe passage. Clear, bright yellow should be used for warnings, as is commonly seen in transportation signage. White strobe lights used in conjunction with audible fire alarms are often invisible when the light falls on white ceilings and walls. Handicap access and fire code mandates result in aisle widths easily perceived and used by everyone, and wide aisles also facilitate communication through Informal American Sign Language.

Tactile indicators enhance wayfinding during emergencies. Knurled or roughened door handles can be used to indicate a hazard behind that door and the same flooring can be used throughout a building to indicate emergency egress. Care should be taken so as to be consistent throughout an entire building, complex or campus. Lack of standardization weakens usefulness.

On a personal level, ergonomics enters the office environment. Ergonomics pertains to length of reach, strength (pushing, pulling, or lifting) and stamina, skeletal support and blood circulation. Problems with reach can be easily addressed by systems furniture and common sense placement of equipment. Strength and stamina limitations can be solved by shortening distances for walking or arm use. Additionally, door closers can be adjusted.

An ergonomically designed chair is essential for everyone. To prevent back pain, the chair back should be fitted to each person. Chairs can be borrowed from dealers or manufacturers for onsite use and evaluation. Problems with poor lower body blood circulation can be lessened through the use of a "waterfall edge" on a well-developed chair seat.

Office accommodation is not a new concept. As long as there have been employers and employees, we have been making adjustments in work environments. Long legs, short legs, left-handedness and eye sight have been subject to scrutiny and are the causes of adjustments. How many of us have sat through Thanksgiving dinner with the youngest family member bolstered to table height with cushions and telephone books? Adapting the environment to suit individual needs is surely not a new concept. Clearly, some adaptations have more panache than others. Creativity, innovation and some degree of skill have wrought clever contraptions of all shapes and sizes to suite a variety of concerns. So the hullabaloo over "reasonable accommodation" in the work place is somewhat unseemly.

Determining appropriate and reasonable accommodation for an employee with disabilities is a process of gathering data, understanding the specific job functions and embarking upon a systematic problem-solving approach.

The process of job accommodation includes the demolition of physical and dissipation of nonphysical barriers. Recent proposed legislation suggests that: "reasonable accommodation shall include (a) making existing facilities used by employees readily accessible to and usable by individuals with disabilities, and (b) includes job restructuring, part-time or modified work schedules, reassignment, acquisition or modification of equipment or devices, appropriate adjustment or modifications of examinations and training materials, adoption or modification of procedures or protocols, the provision of qualified readers or interpreters, and other similar accommodations" (proposed Americans with Disabilities Act). The issues of concern involve the ease with which everything from the parking space to the work station is actually used. Physical accessibility is no longer the only issue; information must also be accessible in many forms.

What are the implications from an interior design perspective? Every interior design project, regardless of size, follows the same basic elements and procedures: programming, design development, specification and implementation. This analytical process ensures that all requirements are identified, problems are pinpointed and resolved in the final design solution.

***Programming*** involves the development of requirements for excellent broad range accessibility. This is the most critical segment of the design process. The job analysis, environmental analysis, worksite analysis and technological analysis are intertwined. As an example, the choice of a large print computer monitor (technology) would affect the level of communication (job) for an employee, and the size of the immediate workstation (worksite). The electrical capabilities of this station affect the overall building environment, and possibly the placement of that workstation within the office area (environmental). A team approach, using the teams listed below, appears to be the most appropriate communication vehicle as shown in the following chart.

- Job Analysis
    - Personnel Specialist
    - Manager
    - Rehabilitation Engineer
    - Facilities Manager
- Technological Analysis
    - Rehabilitation Engineer
    - Employee
    - Manager
    - Interior Design Consultant
    - Facilities Manager
- Worksite Analysis
    - Employee
    - Interior Design Consultant
    - Facilities Manager
- Environmental Analysis
    - Employee
    - Interior Design Consultant
    - Manager
    - Facilities Manager

The job analysis includes the obvious participants, personnel specialist, rehabilitation engineer and manager at the same time including the facilities manager. The initial discussions can then solicit comments on simulation techniques for areas of possible adaptation and initiate creative accommodation thinking.

The technological analysis introduces the employee as expert in identifying his/her requirements. The rehabilitation engineer brings expertise in assessing possibilities of existing equipment. The manager, interior design consultant and facility manager remain active team participants to complement the accommodation strategy.

During the worksite analysis, the facilities manager is joined by the interior design consultant and the employee to develop the fine detail. They address the question: "What must actually be done with furniture, seating, lighting, acoustics and flooring in the workstation?"

The same group, employee, interior design consultant, facilities manager and manager, are brought together for the broader environmental analysis, ensuring realistic and reasonable accommodations. With the research phase complete, the design team evaluates the resulting data and develops a design plan.

***Design development*** is the translation of the programming facts into the physical layout. Design development uncovers inconsistencies between the desired and the realistic. A variety of solutions may be proposed and refined until the best budget and accommodation decisions are made. The resulting documents are architectural drawings and schematic diagrams.

***Specification*** includes assessment of existing furniture and equipment and its usefulness to the proposed solutions. The specifications consist of instructions to any building trades involved in making modifications to the building and worksite. Electricians, carpenters, painters, flooring and furniture and equipment installers are informed through detailed construction drawings and specifications. Furniture and equipment orders are placed based on the specification documents.

***Implementation***, the final phase, translates the design plan to workplace reality. All furniture, fixtures and equipment are inspected and approved, assuring that quality and specification criteria are met. Serving as project administrator, the design consultant monitors accurate placement and installation procedures. In this way, design intent and integrity are preserved. The resulting worksite meets all functional requirements, yet is responsive to the individual employee's needs.

Investigation of federal, state and local codes is encouraged at the outset of any design project. Building codes, fire and safety codes, electrical codes, even accessibility codes, vary substantially from state to state. The project's scope will generally determine code compliance considerations. New construction and major renovation projects will trigger many more code requirements than a minor worksite modification. However, code compliance ***should always*** be assessed. Even trivial modifications can represent a code violation. For example, since smoking is prohibited on elevators, Company ABC dutifully installs ashtrays at all elevator entrances. The ashtray, placed just beneath the elevator button, becomes an accessibility obstacle for a person who is blind. Accessibility and safety codes are thus violated.

ANSI A117.1-1980 and BOCA codes represent national guidelines; state and local guidelines are published and available, as well. The Architectural and Transportation Barriers Compliance Board can also help in providing further information. The ANSI Uniform Federal Accessibility Standards, for example, can apprise one of diverse accessibility design issues such as types of assistive listening systems, cane range of visually impaired people, the proper diameter of a handrail, maximum threshold height, door opening force, illumination levels in elevators, size of openings in gratings, carpet pile height and the like.

The Architectural and Transportation Barriers Removal Tax Deduction, Section 190 of the Internal Revenue Code, provides a $35,000 tax incentive to businesses to make their facilities and vehicles accessible to disabled and elderly persons. Further information is available from your local IRS office.

Other programs, such as the Targeted Jobs Tax Credit, may be available to provide support and financial assistance to companies interested in the employment of people with disabilities. Local vocational rehabilitation service organizations and state agencies are a valuable source of information.

# Federal Accessibility Policy: A Tool for Advancing Innovation

**Susan Brummel**

The federal government is the most complex information environment in the world. The volume and complexity of the information-based responsibilities of its two million employees are rapidly increasing together with the public demand for responsive, accessible services. GSA's Information Resources Management Service is working with other agencies to meet the information access needs of persons with disabilities. A recently introduced policy has made it mandatory for the federal government to provide equal access to its vast array of information resources. Applying effective information technology to support the mission of the federal government to serve its citizens represents an important federal information resources management goal for the 1990s. This paper focuses on a review of the impact of this new policy on the relationships of people, information, and technology.

There is strong support by both the Administration and Congress of the efforts of GSA and other agencies to apply emerging information technology and services to achieve the greatest value for persons with disabilities. Electronic equipment accessibility is the application/configuration of information technology in a manner that accommodates the functional limitations of individuals with disabilities.

GSA began advancing this concept of computer accommodation in 1985, through its Interagency Committee for Computer Support of Handicapped Employees and its Clearinghouse on Computer Accommodation. In 1986 and 1988, Congress passed two laws that support and promote this role for federal information resources management (IRM) programs. The laws are Public Law 99-506, the Reauthorization of the Rehabilitation Act of 1973, and the Telecommunications Accessibility Enhancement Act. These two laws and their implementation will be reviewed.

These laws do not represent a radical new direction for agencies, but serve to reinforce through a strong IRM focus, existing mission requirements under the Rehabilitation Act of 1973. This Act requires federally conducted or federally sponsored programs to be accessible to persons with disabilities. In 1986, Congress amended this legislation and added section 508 reflecting the importance of information technology to meet mission responsibilities for accessibility. GSA's regulation implementing Section 508 was issued in November of 1988 and addresses agency responsibilities to ensure electronic office equipment accessibility when procuring or leasing equipment.

The Telecommunications Accessibility Enhancement Act, passed in 1988, mandates a pro-active approach to advancing accessibility to the federal telecommunications system by hearing-impaired and speech-impaired individuals. In addition to becoming responsible for the management and expansion of a federal relay system for users of Telecommunications Devices for the Deaf (TDD), GSA was tasked with several related responsibilities (e.g., developing a directory of agency TDD numbers) designed to improve the ability of speech impaired and hearing impaired citizens or federal employees to conduct federal-related business. The last major GSA responsibility is to ensure that the evolving Federal Telecommunications System supports the technological advancements possible to meet the need of the federal government to be accessible.

In October, 1989, GSA issued a regulation and bulletin outlining agency responsibilities for integrating accessibility into the management of telecommunications resources. Paralleling 508 regulations, agencies must similarly identify telecommunications accessibility requirements and address the functional aspects of these requirements in solicitation documents and when subscribing to services.

Although education and awareness of any new responsibility takes time, GSA's accessibility policies have been well-received by agencies as a sound IRM practice to address human and information resource issues.

A number of initiatives are taking place within agencies, led primarily by IRM managers, to develop accessible information environments. The activities include education, technical support and information exchange, acquisition planning, and program replication. GSA's Interagency Committee continues to conduct annual symposia. GSA's Clearinghouse on Computer Accommodation (COCA) provides ongoing support to agencies in all aspects of accessibility management from introducing enhancement capabilities in their model demonstration center to briefings that assist agencies to establish similar support capabilities. COCA also conducts monthly meetings with agency counterparts and acquisition planning workshops.

Agency activities include replicating technical support capabilities introduced by COCA, conducting technology fairs of accessible equipment, and development of a variety of accessibility-oriented product and service contracts to meet existing needs of individuals within agencies. Large acquisitions that integrate accessibility management and equipment functionality are just beginning to appear. Agencies are not planning future acquisitions with greater attention to the diversity of human requirements for productive use of information technology.

Access capabilities and support services must continue to become integral to the federal IRM planning and acquisition process. Agencies must conduct an assessment of agency needs including access-related functionality as minimum requirements in solicitation documents. The responsibility then shifts to vendors to respond to these proposals. Users with disabilities must receive equivalent information services, equipment, training, and technical support as users without disabilities. In addition, users with disabilities must receive appropriate accommodation-related software and hardware and training.

The changing federal information infrastructure reflects the convergence of computer and telecommunications capabilities. In addition, it lays the foundation for an effective interface between individuals and organizations. By successfully accommodating their disabled employees, agencies promote productivity, job retention of employees that develop disabilities, and the introduction of innovative interfaces to enhance access to information by all users.

This responsibility coincides with the establishment by GSA of one of the largest information service networks in the world, the Federal Telecommunications System (FTS) 2000. As implementation proceeds, FTS2000 will provide the integration of voice, text, and video services throughout the government. It makes possible for the first time a unified electronic mail system and high-speed FAX between government locations.

GSA is beginning discussion with IRM leaders in all agencies to evolve practices that will optimize use of the new computer and telecommunications capabilities that FTS2000 supports. The potential of service offerings such as electronic mail, voice mail, FAX, electronic directory and messaging services to advance agency missions and to increase service responsiveness to the public is unlimited. FTS2000 reflects GSA's commitment to assist agencies acquire and manage information resources that provide the greatest value to the public not only in terms of tax dollars but also larger public interests such as access to public information resources.

In addition to the general productivity returns anticipated from FTS2000, a further benefit will be the ability to bridge the communication barrier between two individuals when one has a severe hearing impairment, speech impairment, or both.

GSA's IRMS has established a team of in-house experts in telecommunications, accommodation, and policy to identify, through consultation with hearing impaired and speech impaired individuals, the computer and telecommunications capabilities that show the most promise in supporting communication when one individual is unable to hear information and/or communicate by voice.

Some of the emerging service and product capabilities under review include electronic or E-mail, FAX mail, voice mail, tele-and LAN-based video conferencing, and audio and text information services. The anticipated innovation advantages of this evolutionary pilot approach include: a) more rapid institutionalization of services to support federal employees with hearing or speech impairments, b) improved access to the federal government by citizens with hearing and speech impairments, and c) integrated information service planning and delivery models that can be replicated by agencies to meet their mission needs for accessibility.

Today, an important measure of evolving communication and information systems is their capacity to serve the needs of both the individual and the organization. As cost and availability issues slowly recede, utilization issues must be addressed. For many individuals these issues might be summarized as system incompatibilities (I can't make it work), system complexity (I don't remember how to do it and I can't find it) and system/organization protocol (How do I know whether the right person or office got it?). Because of these actual or perceived problems it takes a long time for individuals to augment familiar (i.e., use of phone) with unfamiliar but potentially more efficient practices (i.e., E-mail, voice mail, FAX, bulletin boards, automated attendant services).

This negatively impacts agencies' efforts to advance services to citizens. Citizens expect and deserve quality service. They remember personal experiences far more vividly than agricultural, scientific, or technological breakthroughs that may be stimulated by the federal government. Personal success or failure to access the proper information source in the government becomes their measure of quality service.

Unfortunately, the size and complexity of the federal government makes it difficult to consistently provide the information requested or correct referral to the office that could easily respond to the request. Frequently, overwhelmed and frustrated by difficulties locating information or information experts desired, the citizen just gives up. This breakdown of the user-interface during interaction with an organization is a challenge that all organizations, including the federal government, must address.

It has been recognized that within any such organization will be the pioneers who will make every effort to test new information systems to their limits over a period of time before deciding which new capabilities offer sufficient payoff to adopt into their daily routines. What has not been realized, however, is the existence of a small but important subset of these pioneers who not only adopt most of the new electronic services but also continue to add enhancements in an evolutionary manner that are frequently one or more steps beyond the typical user and include software and hardware features and functions that may be completely foreign to most users.

The initial beneficiaries, persons with disabilities, are innovators and pioneers of information products and services.

Due to GSA's early and ongoing technical information exchange with these pioneers through its Clearinghouse on Computer Accommodation, the important contributions of persons with disabilities as innovators are now being recognized. There are significant information and human resource issues that employees with disabilities can assist with today. As highly proficient users themselves, they have an important role as in-house experts to assist agencies that are integrating information flow procedures to eliminate inefficiencies in the processing, transmission, and storage of information across organizational boundaries. Employees with disabilities can also assist agencies to understand accommodation practices that promote job retention of persons who develop disabilities.

Persons with vision, hearing, or mobility impairments need to be recognized as innovators because their functional limitations make them more reliant on the advantages obtained from exploring and stretching the capabilities of information technologies. They have a greater stake in how electronic-based services or products take shape because the alternative, information that is available in print only or voice only, is of minimal usefulness. Persons with disabilities are more likely to use information technology effectively both at home and at work and have integrated the smooth flow and storage of electronic information wherever possible.

They don't wait for human factors engineers or large manufacturers to ensure their effective access to information but rather break their own ground when necessary by writing the software needed. Through sustained use of speech-based technologies such as text-to-speech and speech recognition they are advancing these interfaces for eventual use by others. They continue to refine and customize their own information processing environments by adding new features or components such as scanners, pagers, hand-held computers with speech output, programmable keyboards, and keyboard macros.

Frequently, the solution to an information bottleneck experienced by one type of information-preference individuals also serves as an advantage to other individuals who are open to the possibilities. An individual who actively explores the range of electronic systems available and then customizes procedures to maximize the compensatory value of these resources also develops insights that can be applied to increasing both individual and organizational effectiveness.

Age-related hearing, vision, or mobility loss is an inconvenience but need not be handicapping to a person's continued ability to perform his/her job. Current workers between the ages of 20 and 40 will experience the highest rate of onset of disability in the next ten years. The National Disability Policy Center indicated that effective job retention programs could reduce by between 21-43% the number of people with disabilities who would otherwise be jobless and/or dependent on welfare by the year 2000. People with disabilities can assist agencies to accommodate employees who acquire disabilities.

Understanding how people with disabilities employ and exploit information resources will help to dispel the erroneous limitations that are associated with the term "the handicapped" People with impairments of vision, hearing, or mobility place greater reliance on electronic information services to minimize potential information flow bottlenecks. A look at the technology solutions used by people with disabilities highlights how these users are breaking down the information boundaries that also constrain organization effectiveness and limit information and human resource innovations.

The information system bottleneck for people with no usable vision is due to difficulties with information that is transmitted only in hard-copy printed forms. A blind individual is likely to be an early and dedicated user of voice mail. There is no barrier to access or need to depend on others to take messages. An additional benefit is the control achieved by the user to choose the periods of time in a day that will be devoted to telephone interactions. Voice directory or automated attendant services that are being implemented in agencies would also be highly valued. These information services provide ease of access to desired information that is accurate, complete, concise, and available at any time.

To manage the flow of text information, a blind person would use a computer and headset that provides spoken output of screen information, under his control and audible only to him/her. Reports submitted for review would be sent to his/her E-mail address and would also leave his/her office electronically. A scanner used in conjunction with the text-to-speech system would allow him to listen to documents received in printed form only. As an early user of CD-ROM technology, accessing needed documentation would become an efficient and valuable activity. When an appropriate section is located, the system would read it to him. A fast rate of speech output would be chosen for information skimming and a slower rate for reviewing a specific problem area.

Customized keyboard macros would be employed as a means to efficiently log on to various mainframes in the course of the day. A "notable" pocket computer with speech output would be used at meetings to record notes. It is also convenient for travel by allowing working files to be downloaded to the office or daily electronic news service files transferred for review during travel.

Individuals with limitations of hand strength or ability to execute the fine movements necessary for writing or the manipulation of documents or books also experience unnecessary constraints when material is not available in electronic form. An individual with limited ability to use a standard information device such as a telephone or keyboard also benefits from many of the computer accommodations employed by blind individuals. A hands-free telephone capability either stand-alone or computer-based provides this individual with similar information access advantages of voice mail and automated attendant services as achieved by blind individuals. In addition, this individual would benefit from bulletin boards, E-mail, and related information services when an effective means for interacting with information devices is established.

In many instances, combining several input strategies yields the greatest returns. Key to the success of this approach is the ability to emulate any keystroke, keystroke combination, or mouse control available to other individuals in the same environment. One solution approach might take the form of speech recognition together with keyboard macros and related keyboard enhancements. If the individual's computer is configured for telephone emulation, a speech recognition system could be employed to bring up the telephone management system and auto-dial the call to be made.

Speech recognition has been heralded for a long time and has frequently failed to measure up. Individuals with mobility impairments represent one class of users that are actively piloting how current speech and related input capabilities can augment their information processes. Organizations gain, not only from the increased effectiveness of these users, but they also can determine the appropriate time and place to "buy-in" and institutionalize elements of these capabilities to improve organization effectiveness.

Individuals with hearing impairments experience no difficulties with printed documents but, rather, are at an extreme disadvantage if information is only presented auditorially, either through live presentation or voice-only telecommunications.

Individuals who are unable to use a telephone due to the extent of their hearing loss are adversely impacted by their inability to benefit from auditory information. A subset of these individuals are also impacted by a speech impairment that may constrain or prevent them from effective oral communication. Within office communication needs can be addressed through a variety of means, including interpreters and use of American Sign Language.

Across office communication needs require other types of accommodations. Voice mail is an effective strategy for individuals who are able to speak. The caller would again instruct the receiving office regarding the desired information and how it should be conveyed: TDD, FAX, E-mail, letter. The individual who is not able to speak is likely to turn to a TDD or TDD-emulating computer. A receiving office with a TDD could be called directly and the user would interact "on-line" with the receiving office by text message turn-taking. An individual could also call a text attendant service (bulletin board with text equivalent of automated voice attendant service).

Individuals with significant speech impairments are adversely impacted only when the information environment requires them to convey information orally and fails to allow for an alternate information channel that they could more effectively use. Many individuals employ portable augmentative communication systems with text-to speech output and the capability for messages to be prepared in advance and stored.

Voice mail would be an effective way to initiate contact with an office because a message could be prepared in advance introducing the receiving party to the caller's use of artificial speech. The information request would include the caller's preferred means of sending the information which could consist of any of the following: FAX, E-mail, voice mail, direct TDD or TDD relay, answering machine, or direct connection and conversation with the caller.

Bulletin boards and voice attendant information services would also have high value to this individual as a means to actively find and review desired information without having to convey the request orally.

This is just a small sampling of information system capabilities employed by persons with disabilities today. Effective utilization promotes productivity and ensures access to work-related and public information.

The biggest remaining problems are organizational and technological ones. Many organizations are slow to effectively institutionalize the full complement of electronic capabilities already purchased. This situation is most detrimental to the pioneer individuals who have a greater stake in the new capabilities to achieve professional and personal effectiveness.

In addition, the current level of access to information resources available to blind individuals is being jeopardized by graphic display, optical storage, and user interface systems that fail to accommodate the required spoken output capability for textual screen contents during interaction with an application.

Hearing impaired individuals are adversely affected by automated attendant services that are voice only. The likelihood is high that a TDD device will not be recognized and effectively routed to a TDD-equipped operator, but rather the caller will be disconnected. This represents a significant access limitation. Few organizations are effectively equipped with TDDs to support these hearing impaired individuals directly.

Industry is refining and enhancing products and services to address access issues like those outlined above, now that a federal policy is in place. As a major buyer of information technology, the federal government is stimulating businesses to respond to its accessibility requirement. Five years ago computer manufacturers said accessibility was important but was not their responsibility or market focus. Three years ago they said "Don't tell us how to do our business." Today, not only manufacturers, but increasing numbers of large systems integrators are making accessibility their business.

Corporate commitment is evidenced by new partnerships with accommodation product manufacturers, issuance of accessibility design guidelines throughout companies, and emergence of accessibility design teams. Companies are consulting their own employees with disabilities. Accessibility is becoming an important topic at computer and human factors conferences.

Although the strongest incentive stems from the desire to continue to sell to the federal government, there is growing recognition that access-tolerant systems also help non-disabled individuals to be more productive. Industry must continue to explore how technology can be shaped to create an information environment that meets the needs of users with disabilities.

Just as the 1960s and 1970s reflected a time of rapidly advancing computing performance (i.e., speed, storage capacity, and reliability) for large organization-wide processing applications, the 1980s will be remembered for the personal computing power that became available to individuals. In the 80s, microcomputers and related office automation technology became common and indispensable tools for federal employees. Early attention to the needs of persons with disabilities has become recognized by GSA as an effective means for advancing both human resource and information resource management and innovations. As implementation proceeds on one of the world's largest information service networks to meet the needs of the world's most complex information environment, the role of persons with disabilities as innovators and pioneers is being acknowledged.

Two of the world's most pervasive information tools emerged from early efforts to accommodate people with hearing impairments and vision impairments. The typewriter was invented to serve as a writing device for a blind member of a royal family. The telephone resulted from the efforts of Alexander Bell to encode speech and transduce it into a medium that could be understood by deaf individuals. He failed in this effort but succeeded in displacing spoken language across distances. Combining the two capabilities, of course, was the early typewriter. In the early 60s the teletypewriter was enhanced by a deaf individual to finally give rudimentary telecommunications capability to hearing impaired individuals communicating with individuals who had a similar device.

Today vast amounts of processing power can be applied to these primitive input/output devices giving rise to tremendous expectations for a wide range of possibilities and combinations for accessing, generating, storing, and transmitting information across organizational boundaries and physical distances that can even transcend physical connections (cellular phones, cellular modems, pagers, and infrared keyboards). The value of this processing power, however, can no longer be defined strictly by the old performance terms of size, speed, and reliability.

As suggested by Donald Norman, "Many advances have been made in our understanding of the hardware and software of information processing systems, but one major gap remains: the inclusion of the human operator into the system analysis...The designer must consider the properties of all the system components--including the humans--as well as their interactions."

One of the primary goals of this decade will be putting the components together effectively and extending the electronic-based range of interactions between individuals and organizations. If effective strategies are developed it may be possible to minimize or eliminate the bottlenecks and communication breakdowns that have limited the effective interactions possible between individuals and organizations.

Planning by federal agencies increasingly reflects the total information processing environment, including electronic interfaces with the public and other agencies. As agencies plan integrated information services that are more accessible to citizens, accommodating the needs of persons with disabilities represents an effective means for maximizing the value of the evolving information system. This also serves to promote the range of innovation advances possible. By making the information systems and services of the federal government readily accessible to persons with disabilities, both the individual and the federal government benefit significantly.

The opportunity costs and human resource costs to society are too high not to act. When information resource planning includes the needs of users with disabilities, additional innovation advantages accrue to both organizations and individuals.

As we move forward to explore a new range of possibilities for communication and information exchange between individuals and across organizations, the convergence of computers and telecommunications technologies only amplifies the possibilities. The evolving access policies within the federal government provide focus and direction and serve as a catalyst for innovation.

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***Note:*** This paper was revised after the presentation to reflect more recent information available to the author.

# High-Tech Homework

**Donna Walters Kozberg**

Sometimes it seems almost impossible to keep up with the pace of modern technology, but nowhere is the effort more rewarding today than in the field of rehabilitation. An organization that has sought out the best of advanced computer knowledge and current rehabilitation technology is Lift, Inc. Lift is a nonprofit corporation that trains, hires, and places computer programmers with severe physical disabilities. The firm has worked with over 70 of the largest corporations in the country, and with almost 200 programmers with severe disabilities since its incorporation in 1975.

The first and most important accommodation that an employer can make is often just to say "yes, it can be done", rather than "it's never been done before". Lift has never had to turn away an applicant who was otherwise qualified because of the lack of a way for the candidate to access a computer effectively. Finding a way was often much more difficult only a few years ago. Technology has advanced so rapidly that the prototypes of two years ago were out of date yesterday.

Still, some employers are fearful of hiring a person with a severe disability because they do not want to risk getting bogged down by technical misfortunes, exorbitant expense, and employee down-time. The Lift five-stage process addresses this concern. The approach involves:

- corporate planning,
- recruitment,
- training,
- contract employment, and
- direct placement.

During the ***planning*** stage, Lift works with corporate managers to identify where a corporation is going to have a need for programmers.

The two staffs determine what skills will be necessary for near-future jobs, and what computer software, hardware and communications systems will be used.

During ***recruitment***, Lift seeks individuals who are bright and highly motivated. To the extent that either corporations or applicants have special needs, they are taken into account as people are matched with positions. However, Lift's philosophy is that, if a candidate has the intellectual aptitude, there will be a way for him or her to do the job.

The ***training*** period typically takes six months. During training the programmers use the same hardware, software, and technological aids they will use once they start working. That way, any kinks in the work environment are smoothed out long before they have a chance to slow down a programmer who is trying to do a job and earn a paycheck.

Upon completion of the training program, graduates are hired by Lift. Many of the programmers work from their own homes. The home office is an option that can be useful to people with or without disabilities, for a variety of reasons. Lift does require telecommuters to travel on site at least once a week. They begin with weekly on-site visits at the start of training. That way, all involved with the program learn early about any accommodations that have to be made on site, and the programmers get to know the ins-and-outs of the social structure and physical plant of the buildings they will be working in. If the programmer does not intend to do work from home, Lift will train him or her on site. Again, training, accommodation, and employment are so tightly interwoven that the firm approaches all three as one package from day one.

After a year of contract employment with Lift, the programmers are ***placed directly*** with their corporate sponsors. Employers are taking little risk in making a job offer at this stage. They know the programmers and what they can do. Lift staff keep in touch with the employees after they are placed, and are available to offer advice to corporate clients when they are ready to upgrade hardware or otherwise change their own technology.

There has been a range of accommodations made for Lift programmers, from low-tech to high-tech, from virtually costless to costly. Some benefitted others besides the programmers. Some were complicated solutions to interesting problems; others were simple solutions to complex problems. In almost every situation, the problem-solving process is the same. A problem is identified; the trainee, Lift, and the corporate client confer; and a solution either emerges on the spot or Lift does further research. Rehabilitation engineers and occupational therapists are often consulted.

It is not unusual to have a problem pop up that a manager realizes another programmer must have already solved by himself or herself. Lift's best resource, time and again, has been common sense. The best source of common sense? The employee with a disability.

The advances in available technology have been exciting. Five years ago, voice input was considered impractical for computer specialists. Today, I am often asked which product among many is the best. Five years ago, Lift and its clients were patching together multiple keystroke programs. Recently, a programmer called to tell me his employer wanted to upgrade his software. He did not know which of a dozen commercially available programs was state-of-the-art. Another programmer called a few days later to ask for a shopping list of hardware and software because her employer was ready to upgrade what she had.

Lift has placed several programmers at a large insurance company in New York. Linda, one of the programmers, is a very bright woman with severe rheumatoid arthritis. She works primarily from home, and commutes on site two days a week. When Linda first heard about Lift she was living with her family in a house that was not accessible. The New York State Office of Vocational Rehabilitation arranged to have a lift installed at her house, and to have a bathroom modified. The insurance company made no onsite modifications in her first year of employment there, but recently installed automatic doors to accommodate all employees. Before the automatic doors were installed, a security guard was available to help employees with disabilities at the front door.

Another highly-valued programmer at the same corporation is Bob, a young man with quadriplegia as a result of a spinal cord injury, who had already had a custom-made counter top work space designed and built before he applied for admission to the Lift program. He now uses a special keyboard that allows simultaneous keystrokes. At one time he used a home-developed piece of hardware to enable him to hold down two keys at the same time.

Both Linda and Bob are outstanding employees. Linda had help from the Office of Vocational Rehabilitation, and Bob's family was instrumental in helping him get set up. The employer had to provide little in the way of adaptive equipment. However, the managers at the employing company had a positive, "let's do it" attitude. At the beginning of the project, some of them wondered "how in the world can these people program?" In spite of their private speculations, at no time did they allow their lack of experience with disability to become a barrier.

Lift has some programmers who use voice input to enter their programs. Some use mouth sticks. Blind programmers use speech synthesizers. Some also use braille output. Lift has placed programmers who work from bed. At least one has a moveable monitor arm attached to a wall beside him. Many of the programmers have needed special keyboard holders.

One Lift programmer is using a product that is still in development. He operates his computer, his environmental controls, a telephone, and his wheelchair by a joystick which he moves with his chin. He works for a bank, from home, and is doing very well. Another employee with similar functional limitations at the same bank simply asked to have a work space lowered and was given a speaker telephone. He is also doing a terrific job.

There is no such thing as the perfect work station for any two people with the same specific functional limitation--any more than the work station that would be ideal for you would be ideal for your spouse or your brother or your best friend. The programmers have widely divergent working styles. Some like to use large quantities of paper while others use relatively little paper or computer time, but complete complex analyses in their heads. Some prefer to work very long hours at a stretch; others like, or need, frequent breaks.

Telecommuting is an important accommodation. It is an option that most Lift programmers pick up on. Significant advances in technology have made the portable office a reality. Even so, to allow full-time work from home is usually an accommodation, because the employers Lift works with are typically not allowing their programmers without disabilities to telecommute.

Homework is an old idea whose time may be here again. Before the industrial revolution, men and women did much of their work at their own homes and farms. Now that our economy is evolving further, from a structure based on manufacturing to one based on information processing, a gradual return to home-based work may be underway.

Although many people in both large and small businesses are skeptical about the feasibility of home-based work, there are common examples all around us, especially of self-employed professionals: the dentist with a home office, the accountant, the psychologist, and so on. Even the President of the United States works from his own home!

In spite of the skepticism, the popularity of telecommuting is increasing as businesses and employees discover its benefits. Over half of today's employees are involved with information work--work that can be done almost anywhere because of today's sophisticated computer and communications systems. For many of us, an office is a pay telephone at an airport or a cellular telephone in a car.

Currently, ten percent of the Fortune 500 companies support telecommuting projects, and increased acceptance is probable as study after study demonstrates that homework offers several important advantages to corporations:

- an enlarged labor pool,
- improved retention of employees,
- office space cost control, and
- improved productivity
(Gordon & Kelly, 1986).

Yes, one sure way to increase productivity is to send your workers home! Why? The studies tell us that telecommuters:

- work more hours per day,
- do more work per hour,
- are able to work at personal peak times,
- have faster access and turnaround times,
- are not subject to group performance norms,
- are absent less often, and
- use productivity-enhancing tools (such as electronic mail).

The Hawthorne effect is another likely factor, but one that does not come into play for the Lift programmers, who are all new to their positions. Because the results of many studies may have been skewed by the fact that corporations tend to send their best and brightest home, a 1986 study of Lift programmers by students at Rutgers and Columbia Universities used an equal number of computer specialists who had been rated as "average" and "superior". As a group, the two most highly perceived advantages of telecommuting were flexibility in working hours and higher personal productivity (Gorman, Kozberg, Kozberg, & Sprole, 1986).

There are many potential employees who are unable to work full time, or who are unable to work standard nine-to-five office hours for one reason or another. Employers who support telecommuting can also attract employees who live relatively far away from the office, but who would not mind the commute one or two days a week if they were able to do most of their work from home. Employees with short or long term disabilities may have problems with transportation and scheduling and may have special needs that are best met at home.

The potential benefits to employees are obvious. Transportation costs and hardships are reduced. Many people with serious disabilities find travel physically difficult. Some may be able to handle a lengthy commute once or twice a week, but not every day. Clothing expenses usually decrease for people who work from home, and clothes worn at home can be less restrictive than business suits. Work hours can be flexible to allow for unique needs such as physical therapy or rest periods.

The advantages to Lift's corporate clients are many. They gain a proven resource for competent workers who are likely to continue as long-term and highly-valued employees. Working with Lift also affords client companies the opportunity to experiment with the work-at-home concept in a controlled, exclusive manner.

An indirect benefit to companies with homeworkers is that managers learn to appraise performance rather than activity. Many managers have become accustomed to judging a person's performance in part by how busy he or she seems to be. The experience of managing one or more homeworkers gives managers new skills at assigning work, establishing objectives, and evaluating results. These skills can be applied to on-site use just as effectively as they are used to supervise telecommuters.

Communication must be more efficient on the part of the telecommuting worker, both while he is at home and while he is on site for meetings. There may not be much time for fruitless conversation. However, Lift programmers report that they do develop good relationships with other people who work in their departments. They find opportunities to socialize and develop friendships both during their visits on site, and via the terminals. In fact, I learned how gregarious one computer specialist was via his computer network when I visited him at his home. He switched on his terminal while I was there, and I saw messages about hockey scores, a Saturday night party that was being planned, and a secret access code for a new computer game.

It is likely that most people have at one time or another thought about whether they would like to work from home. Many people assume that they would miss the social life at the office too much to make the change. On the other hand, if telecommuting becomes widespread, the neighborhoods we live in could become close-knit communities again, rather than simply places to store our bedrooms.

My prediction is that in the next few years telecommuting will continue to gain in popularity in the quiet, steady, almost underground way that it has been. And tomorrow, all of us will surely be using technological aids that we cannot even imagine today.

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# Rehabilitation Engineering Applications for Low Back Pain and Other Disabilities

Gerald Weisman

The Vermont Rehabilitation Engineering Center (REC), the only federally-funded research center for the study of low back pain, was established at the University of Vermont in 1983 by a grant from the National Institute of Disability and Rehabilitation Research. The Vermont REC conducts basic and applied research, and provides rehabilitation engineering services to those with low back pain and other disabilities.

Low back pain is the most common musculoskeletal disorder: Up to 80 percent of adults experience low back pain at some time in their lives. Disabling impairments of the back or spine are the leading cause of disability in the United States, affecting 2.3% of the population. About one third of all injuries result in low back pain and these account for more than half of the costs attributable to workers' compensation. Low back pain has been called a "hidden disability" -- that is to say, since it involves no obvious deformities or prostheses, it is not usually possible to determine, at a glance, whether someone has low back pain.

Low back pain is not limited to those who work in industrial settings or who do heavy manual labor; many people in service industries and white collar jobs also suffer from low back pain. However, low back pain is most common among those who must perform repetitive lifting tasks, particularly in combination with bending and twisting. Some of the current research at the Vermont REC is directed toward analyzing the tasks involved in various occupations. This research project aims to characterize different occupations and specific work tasks in terms of loads placed on the spine in different postures. It is not only the weight of an object that must be considered, but its size and shape as well. The reason is that the amount of load placed on the spine depends on how close to the body the object is held when it is lifted. Naturally, a large, bulky object cannot be held as close to the body as can a small one.

Researchers at the Vermont REC are concerned with designing safe workplaces for able-bodied people, as well as workplaces that can accommodate people with low back pain and other disabilities. Guidelines set forth by NIOSH (National Institute of Occupational Safety and Health) include an "action limit" and a "maximum permissible limit." The action limit is the point below which anyone can lift; the maximum permissible limit is the point above which no one should be allowed to lift. However, between those two points is a wide range of weights and individuals vary in the amounts they can lift safely. Appropriate job modifications could ensure that tasks are within limits that are safe for everyone. In order to modify job tasks to ensure safe lifting, much information is needed about workers, worksites and work tasks. A good first step is to determine what a worker can do (as opposed to what a worker cannot do). It is unfortunate that, when people with disabilities are evaluated, what they cannot do is often emphasized -- for example, perhaps they cannot see, or hear, or walk, or lift. In order to apply technology at the worksite, it is more important to determine what people *can* do and how technology can be applied to enhance those abilities.

One of the most important things to know about workers is how strong they are -- or, put another way, how much they can lift. Strength can be tested by using different machines, many of which are commercially available devices designed to test strength in different ways. Some machines test ability to lift straight up; some test the strength of specific muscles.

There is an old joke: Which is easier to lift, fifty pounds of feathers or fifty pounds of gold? Obviously, the feathers and the gold are of equal weight. But they are not equally easy or difficult to lift. The gold should be easier to lift because it can be fitted into a smaller container than the feathers and, thus, held closer to the body. From the study of biomechanics and computer modeling, we know that strength changes with range of motion and that people can lift a great deal if they lift close to the body and below the knees. On the other hand, lifting from the shoulder, for example up over the head onto a shelf, is much more difficult. A person might be able to lift 160 pounds when the weight is near the knees; but the farther the weight is from the body, the less that same person will be able to lift. At full arm's length from the body, that person can lift only 10 pounds safely. This kind of information -- strength throughout a range of motion -- is the kind of information that employers need when they design work tasks and when they decide who is to do which tasks.

As part of another research project at the Vermont REC, we have been developing ways to measure lifting capacity throughout a range of motion. We measure the amount of weight that people can lift at certain distances from their bodies, asking them to lift isokinetically (that is, pulling on a handle as hard as they can at a constant velocity). After testing at four different distances, a plot (Figure 1) is drawn that graphically illustrates lifting capacity. Figure 1 shows that strength can be measured and depicted throughout a range of motion. An employer can use this type of information to design work tasks that do not require workers to exceed their strength. For example, most workers can lift much more weight from floor to waist height than to an overhead shelf.

Using such information about lifting ability throughout a range of motion, it's possible to redesign worksites to promote safe work practices. The Rehabilitation Engineering Center, through its affiliate, Rehabilitation Technology Services, provides worksite assessment services to employers who wish to reduce risk of low back and other injuries on the job. Assessments typically require an analysis of work tasks, worksite design, and workers' physical capacities. In one machine shop, workers were found to be lifting heavy stock from the floor. Our team recommended that the stock should be at waist height, so that workers would not have to lift it while bending forward. In this same workplace, although a five-ton crane was available for lifting, it was observed that when workers needed to lift lighter loads (e.g., 100 to 200 pounds), they often attempted to lift manually rather than to use the big crane. It was recommended that a smaller crane be available for lifting lighter loads.

As another example, an insurance company contacted our center for assistance in redesigning a work task. At this company, a 500-pound, wheeled cart was used to move reels of magnetic computer tape from one building to another. The moving was done routinely as part of a "Disaster Plan," so that if one building burned or were destroyed, records would be safe at another location. Two elderly women were responsible for moving these carts from building to building, which included moving them up and down ramps; the ramps were built at angles of up to 14 degrees, which is almost twice as steep as a standard wheelchair ramp. On one occasion, one of the women lost control of the cart, which pinned her against a wall and resulted in a low back injury. The solution involved motorizing the carts by placing the front end of an Amigo wheelchair on the back of the cart.

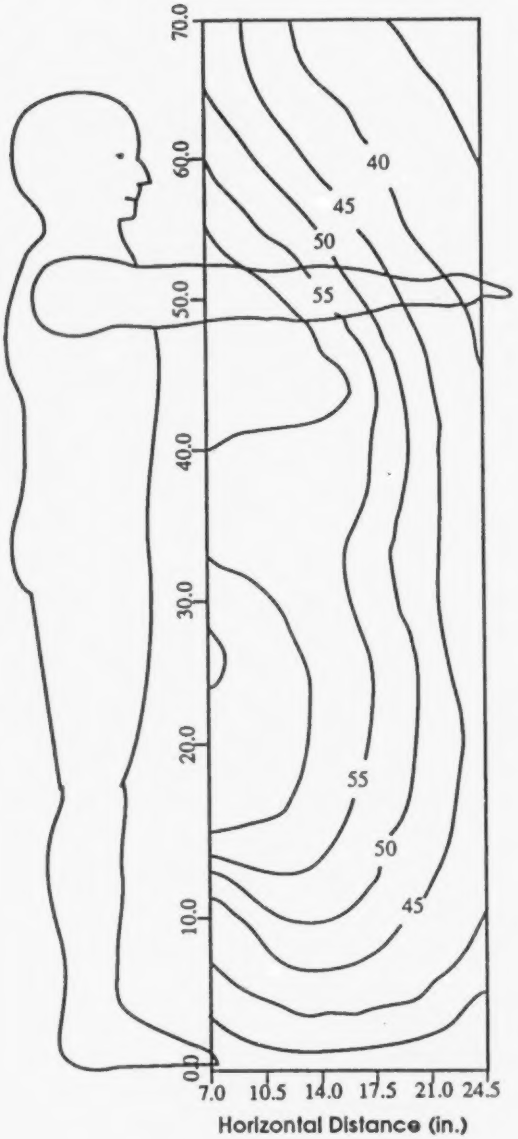

Figure 1. ∏A worker's strength throughout a range of motion can be measured and depicted in the form of a contour plot.

It is well known that an object of a given weight will produce a different load on the spine depending on the posture in which it is lifted. Also, specific postures such as forward bending, or bending combined with twisting, when maintained for prolonged periods or time or when repeated often enough, can contribute to the onset of low back pain. Workers are often required to bend and twist repeatedly throughout the day. Static postures, such as might be involved in a desk or computer job requiring prolonged sitting, can also have a deleterious effect on the spine and low back. Monitoring workers' postures is an important part of worksite assessment. At the Rehabilitation Engineering Center, we have developed a device, called a three-axis goniometer, that continuously monitors postures throughout the course of a workday. The goniometer, which is strapped onto the worker and does not interfere with normal work tasks, simultaneously measures movement in three axes (forward and backward bending, side-to-side bending, and rotation). Also underway is the development of a Workload Assessment System that will incorporate the goniometer as well as a way of measuring the amount of load the worker is lifting when in these various postures. The value of such devices is that they can provide highly detailed information about job demands for specific occupations. This is important since it is impossible to match workers to jobs appropriately without knowing what the jobs require.

One limitation of the goniometer is that it cannot be used to assess the demands of sedentary jobs. It is believed that maintaining static postures over long periods of time can contribute to low back pain. A large proportion of American workers, particularly those in the service industries, now sit most of the day, for example in front of a computer. These workers are particularly prone to eye strain and upper shoulder pain, in addition to low back pain. Numerous seating studies have been conducted at the Vermont REC in an effort to determine ways in which the negative effects of prolonged sitting can be minimized. These studies have involved assessing commercially available "ergonomic" chairs to identify their benefits and drawbacks. Most so-called "ergonomic" chairs, popular in office settings, provide adequate or better-than-average back support -- provided one sits in the chair in a fixed upright position. However, we know that it's important to move from time to time, rather than to maintain a fixed posture; unfortunately, when one changes position, most chairs no longer provide support where it is needed. For example, when one leans back in a chair, the point of greatest pressure is shifted from the lumbar region upward toward the mid-back and shoulders.

One of the seating projects at the REC has involved the design and fabrication of a special backrest that provides continuous passive motion

(CPM) to the lumbar region of the back. When attached to, or incorporated in, the back of a conventional office chair or other type of seating (for example, automobile seating), the CPM device facilitates natural motion of the lumbar spine throughout the day by continually increasing and decreasing the amount of lordosis in the lumbar region in a cyclic fashion. The device is now being tested in REC laboratories; comfort, muscle fatigue and range of motion will be measured in both back-healthy volunteers and those with low back pain after using a chair fitted with the CPM device.

Those whose jobs involve long hours on the road, or who work with vibrating machinery may also be at risk for low back pain and injury. The mechanisms by which vibration affects spinal structures are not well understood; however, it is clear that there is an especially high rate of back disorders among workers who drive trucks, buses and tractors, as well as among miners. Worksite modifications for such jobs involve the use of special cushions and damping mechanisms to reduce the amount of vibration transmitted through the body, especially to the spine.

Rehabilitation Technology Services (RTS) also provides rehabilitation engineering services throughout New England to employers and workers with a range of disabilities. Often, accommodating a worker with an impairment requires only a simple alteration in the work environment. As one example, a snowshoe manufacturer contacted RTS for assistance in accommodating a worker with a physical disability. Most of the company's employees work at home, using a large wooden clamp to hold the snowshoe frame and lacing rawhide to the frame. The employee in question had some dexterity problems and a low tolerance for standing; he could stand comfortably for only about four hours. Thus, he could work well through the morning, making about four or five pair of snowshoes a day, but was not very productive in the afternoon. The primary problem was that the snowshoe frame was fixed, requiring the worker to walk from one side of it to the other in order to tie the rawhide properly. The fabrication of a simple device, controlled by an electric solenoid and activated by a foot switch, that turned the snowshoe frame around allowed this worker to sit on a stool. Both his productivity and his enjoyment of his work increased.

Another modification was undertaken for a client who wanted to work in a garment manufacturing plant. All industrial sewing machines have foot pedals with a toe control and a heel control. Pressing down on the toe runs the machine; pressing on the heel cuts the thread. This particular client, an amputee, had no feet and needed a modification that would allow her to operate the sewing machine. The employer was able to dedicate a sewing machine for the exclusive use of this worker, so the machine was modified by replacing the foot pedal with a pneumatic cylinder, with a double-valved head control. Pressing on one side activated the machine; pressing against the other cut the thread.

As one more example, RTS was asked to assist in accommodating a lineman who had worked for a telephone company for seven years before a fall from a pole left him with a spinal cord injury resulting in paraplegia. Since he had been a good worker, the company wanted to keep him, and found another job for him working in a company warehouse. However, the worker, who had excellent upper body strength and could ambulate with leg braces and a hand hold, preferred working on the lines. He maintained that, if he could use a bucket truck, he would be able to do the job. The biggest problem was the matter of getting into the bucket, since the bottom of the bucket could be maneuvered to no less than four feet from the ground. The worker demonstrated his ability to pull himself up in a "chin-up" fashion, into the bucket. Once inside the bucket, his long leg braces and the small size of the bucket afforded him enough stability to be able to perform the job tasks required. Several modifications to the job and to the equipment enhanced his productivity enough to make him a fully-functioning lineman. The truck was modified by installing grab bars around the outside of the truck. A pole was mounted on the rear bumper to hold the orange plastic cones commonly used to define the work space of a road worker. Once on this pole, the cone did not have to be handled for the rest of the day. The chocks for the wheels were tied to the side of the van and were always in a position in which they could be readily used. Grab bars were also installed on the bucket and a heater was installed in the bucket to minimize risk of frostbite, since the worker had some sensory loss in his lower extremities. The job itself was restructured somewhat so that this lineman could remain at one pole for a longer period of time, thus minimizing the "set-up" time required for each job. Commercially available hand controls were installed to allow the worker to drive the van independently. The total cost of the truck modifications was approximately $3,000.

As many of the foregoing examples illustrate, research, such as that conducted at the Vermont REC, goes hand in hand with service. Research can provide the means (information, as well as tools) by which we can better assess worksites and work task demands, and subsequently develop modifications. Research also provides the information necessary for designing the needed modifications. Technological applications can not only help people with disabilities return to productive and enjoyable work, but can also prevent many industrial accidents and occupational injuries.

# Employment Technology Programs for People with Disabilities: Case Studies of Successful Fund Raising Approaches

**N. Jeanne Argoff**

Most experts who testified in the hearings preliminary to the passage of the Technology Related Assistance for Individuals with Disabilities Act of 1988 said that the lack of financing for assistive technology devices and services was a critical problem. Those people described the current financing systems as "a patched quilt...a fragmented financial support system" focused on medical needs and inadequate for people with permanent lifelong disabilities. They specifically pointed out that the system:

- addresses home-based needs, but not work-related devices,
- provides funding for equipment, but not support services (which are crucial if the equipment is to be utilized effectively), and
- does not offer incentives to the private sector to engage in research and development to increase the availability of reliable and durable devices (100th Congress, 2nd Session, HR Report 100-819).

The report on the Technology Act concludes from this that the inadequacies in financing assistive technology devices and services place significant burdens on individuals with disabilities who need such devices to work and to live independently.

Hopefully, enough money will eventually be appropriated through the Technology Act to rectify part of this problem. We can also look to the Study on Financing authorized under Title II of the Act, and to the networking and coordination required under the state grant program in Title I to clear up some of the murkiness of the funding picture, and to make the quest for funding easier in the future.

Having spent a considerable amount of time trying to track down program funding sources and to distinguish those from funding sources for individuals needing assistive devices, I finally came to two conclusions.

- First, the field needs a how-to manual for obtaining program funding from both public and private sources, and the manual needs to be updated on a regular basis. We at the Dole Foundation commissioned such a manual with the help of the Connecticut Rehabilitation Engineering Center.[1]
- Second, obtaining funding for technology programs is as much a matter of developing attitudes and qualities like creativity, perseverance, pragmatism, and good business sense as knowing which federal agency or private funding source has what kind of money available at what times.

The manual will include detailed case studies of fund raising approaches and practical advice on how to go about getting what from whom. For the present, however, more can be done to shed light on the issue by providing some mini case studies of successful programs to convey the sense of how it is done by people who have managed--through experience, trial and error, luck, creativity and hard work--to do it well. I will also say a few words at the end about what some funders, including The Dole Foundation, look for in making funding decisions.

### Kali Mallik, Alliance, Inc.

One of the early practitioners in the field and the mentor of a number of current practitioners is Kali Mallik. He started off at George Washington University where he was funded in 1967 by the Rehabilitation Services Administration (RSA). Eventually, one program became four programs; and after the Rehabilitation Act was passed, the funding source was the National Institute of Handicapped Research and then, after the name change, the National Institute of Disability and Rehabilitation Research (NIDRR).

Kali Mallik moved to Baltimore in 1983 and opened up a private non-profit agency serving people with all disabilities, including the chronically mentally ill. Major funding--$2.7 million for building renovation and $500,000 a year for program support--first came from a Baltimore County Community Development Block Grant. However, Murphy came up with a new amendment to his law and Housing and Urban Development's new definition of economic development now excludes the provision of rehabilitation engineering as an economic development activity by private non-profits.

The Alliance now operates under funding from the Mental Health Administration of Baltimore County and Maryland State ($900,000 a year); the State Developmental Disabilities Administration (DDA) via the city and county ($300,000) a year; two Social Security Administration (SSA) grants totaling $150,000 to provide rehabilitation engineering for employment opportunities for Social Security Disability Insurance (SSDI) recipients; and about $1 million in contracts from various public and private sources. The major funding sources for rehabilitation engineering are the DDA grant, which funds supported employment services, including individualized support services, for multiply and severely disabled clients, and the SSA grants. Out of a total of just over $3 million in income, approximately $250,000 is devoted to rehabilitation engineering.

Qualities Mallik believes are important for those delivering and obtaining funding for technology services are knowledge of rehabilitation technology and the ability to market that knowledge to case managers, teachers, and vocational counselors. Also important are the ability to allay people's fears about high tech devices, good public relations in the print and electronic media, and strong advocacy skills.

### John Leslie, Jr. Cerebral Palsy Research Foundation of Kansas, Inc.

In 1971 John Leslie was an industrial engineer at Wichita State University when he was approached by Jack Jonas to participate in some rehabilitation technology projects. By 1972, they had formed the Cerebral Palsy Research Foundation of Kansas (CPRFK). The first grant they received was from the Kansas State Department of Education, Vocational Education Branch--an exemplary program grant of $50,000. They worked under that granting source for several years with some initial success but were not able to serve large numbers of clients.

In the meantime, Jonas went to Australia and brought the Center Industry concept back with him. (Center Industries was established to offer full-time meaningful work for people with disabilities and to provide a workable setting for the applied work at CPRFK. Employment is maintained at 75% people with disabilities and 25% able bodied. All employees are paid minimum wage or above and qualify for a solid fringe benefit package.) Jonas and Leslie received a contract for a state set-aside to produce license plates, and obtained vocational rehabilitation funds for staffing and equipment. In addition, they received a Small Business Administration loan at 3% interest under the Handicapped Assistance Loan

Program. These funding sources set the basis for Center Industries, which is a subsidiary of CPRFK.

John Leslie continues to work at the Research Foundation, which uses a variety of sources to fund rehabilitation technology activities. Major sources of funds are two Vocational Rehabilitation grants. One, the Supported Employment Initiative of Kansas Program (SEIK) provides funds to 14 pilot programs across the state. The second grant provides funds to establish a Mobile Rehabilitation Technology Shop.

Other sources of funds include county mill levy monies amounting to about $350,000 per year for mental retardation programs and about $350,000 for people with physical disabilities. These funds, though, can only be used for county residents, and they are needed and used for many services other than rehabilitation technology.

They also receive Veterans Administration funds on a fee-for-service basis, but these funds are primarily available for independent living and not vocational technology. Other fee-for-service sources are Vocational Rehabilitation and private rehabilitation vendors through workers' compensation funds. This last source is a random one unless there are a number of clients in the pipeline.

Finally, they have a U.S. Department of Education grant (Title VI B) for school-to-work transition. While this is not specifically targeted at vocational rehabilitation, they can pay for some technology under it. All in all, 75-80% of the Center funding for technology is from grants.

Qualities needed to obtain funds are the willingness and ability to look beyond the traditional players (e.g., Vocational Rehabilitation, the Social Security Administration, and the Veterans Administration) to programs like Javits-Wagner-O'Day, which provides the opportunity for people with disabilities to work directly through government set-asides. The cultivation of the bureaucratic skills required to get through the maze of regulations is crucial; but one of the problems of developing bureaucratic allegiances with agency personnel in decision-making positions is that there is great turnover in personnel, especially in state vocational rehabilitation agencies.

### Sam McFarland. National Rehabilitation Hospital

Sam McFarland came to the National Rehabilitation Hospital (NRH) in Washington, D.C. after working at IMPART and another rehabilitation engineering center. Many people may remember IMPART as one of the early rehabilitation engineering efforts funded by NIDRR. Apart from rehabilitation technology experience, McFarland learned from IMPART how crucial the ongoing funding mechanism is for a technology program. IMPART was funded for five years, and when it reverted to the state, the state was not prepared to put enough money into it to sustain it as an ongoing operation. While its current director has built it up some from its low point a few years ago, IMPART, which has since changed names, still suffers from lack of adequate funds and has not sustained its initial promise.

When McFarland came to NRH in 1985, the Hospital had the beginnings of a rehabilitation technology program in place plus a vocational rehabilitation service that was not using technology. What was needed was a mechanism to combine and optimize those two efforts without placing the hospital at risk. And what they did not really know at the time was what they could obtain payment for, and what technology could really do.

In 1987 they received a grant from the Social Security Administration (SSA) for approximately $140,000 to develop a demonstration model on procedures for utilizing technology in the vocational rehabilitation and employment of Supplemental Security Income (SSI) and Social Security Disability Insurance (SSDI) recipients. A major problem experienced by NRH and other rehabilitation technology providers who are funded through third party sources is that most of those third party providers would pay for equipment but not labor. What the SSA grant did was to pay for the labor in a very labor intensive technology intervention project. The grant enabled McFarland and his staff to demonstrate the integration of technology from the earliest stages, i.e., during in-patient stays, of a vocational rehabilitation program.

They discovered that the early intervention set up the vocational rehabilitation process for success. At the same time, they also attracted professionals interested in worksite modification design from Vocational Rehabilitation and elsewhere, and they obtained a $3.25 million dollar grant from NIDRR to establish a Rehabilitation Engineering Center on Evaluation of Rehabilitation Technology.

Also during that first year of the SSA grant, the NRH staff began to realize that a worksite accommodation model was also needed. A second grant from SSA was obtained to demonstrate a team approach (vocational rehabilitation counselor, occupational therapist and rehabilitation technologist) to worksite accommodation, and to create and implement a training program on the team model.

While operating under these grant monies, NRH is also in the process of obtaining referrals for paid service and building a solid fee-for-service business from private insurance agencies, employers, and Vocational Rehabilitation.

The quality McFarland saw as most important for obtaining funds is business sense. Often, rehabilitation technologists who are good at the technical end of the business have developed a research and grant mentality which serves them well as technologists but does not help the business end of a technology equipment and service program. One suggestion is to create teams of technologists and business-oriented people in order to assure a practical approach which combines needed skills from both areas.

### Michael Behrmann, George Mason University

The George Mason Center for Human Disabilities, directed by Michael Behrmann, has been in existence for less than a year. It gets approximately 50% of its funding from state grants and contracts, 30-35% from federal sources and the rest from a mixture of foundations, private corporations, and local government agencies. Of the 21 people employed in the center, all but Behrmann are supported by external funds.

It is difficult to separate the funding streams at the Center because of its policy of mixing, merging, and matching personnel with various expertise from throughout the university to bring a comprehensive teamwork approach to bear on projects. Fiscally, it was designed to umbrella externally funded operations and reaches out to other departments and disciplines in the university. Where projects can coordinate with each other to the benefit of both, they do so--taking care, always, not to overstep the regulations governing each grant.

Because of space constraints, I will only mention a few of the funding sources used to support the Center's vocational technology activities. A major source of funds is an Office of Special Education and Rehabilitation Services (OSERS) grant of $175,000 to develop and support an expert system, ADAPT/PC--which is an acronym for Assisting Disabled Persons to Access Personalized Technology/Professional Consultant--to evaluate the technology needs of people with disabilities. Under ADAPT/PC, the Center staff will develop a model assessment program. In a related project, the ACTION (Action Computer Technology Assessment Center), they will configure the system, provide training on the hardware and software for rehabilitation professionals, training for aides and family members to support their disabled working family members, and reassessment to enable job growth and/or modification. ACTION will be funded by clinical service money received on a fee-for-service basis.

IBM is a new source of funds for the Center, which has just signed a contract with the company to become one of three regional special educational resource centers working through the Special Needs Center in Atlanta.

Another source of funds is the private sector. The Center has a variety of ways of working with the private sector, including general contributions for the Center's endowment and ongoing operation; special program funding; and services provided by the Center to businesses (for example, product evaluation and assessment services for companies responding to the Electronic Accessibility Act).

Virginia Department of Education funds support two technical assistance centers staffed by the Center--one for severely profound deaf/blind and one for pre-school children. While these two centers do not have a vocational focus, some technology activities are included.

The qualities Behrmann and his staff stress in the fund raising realm are creativity, energy, and a solid business sense. They firmly believe that program operators cannot rely on any one funding source but must continually till the funding fields and cultivate a mix of sources.

## Summary

The first striking aspect about the list of funding sources that emerged from my interviews is, on one hand, the mix of traditional and nontraditional sources and, on the other, the fact that such sources as county mill levies and community development block grants--often unthought of but not especially exotic resources--were being used.

Few of the practitioners relied on single funding sources. Most have their own version of the patchwork quilt of funding mentioned in the report of the Technology Act. Qualities such as creativity, imagination, business sense, good communication skills, and the ability to look beyond the obvious were mentioned frequently as crucial to successful funding.

Someone whose program I did not mention--Penelope Caragonne from the Connecticut Rehabilitation Engineering Center--thinks that good technology fund raisers have to be able to look at an ambiguous situation and have enough anxiety to want to impose order on it.

What do funding sources look for? I wish there were one easy answer. One big problem with funding for rehabilitation technology is that many of the funding sources do not yet understand much about the field. It is safe to say that most funding sources need to be convinced that the programs are worthwhile and cost-effective in principle and that they are relevant to the mission of the funding organization. While most applicants understand that in the abstract, they often do not convey this knowledge in proposals; or they do not make an effort to speak the special language of the funding agency. At the Dole Foundation, we look for innovation; replicability; programs that serve new populations in underserved areas; involvement of consumers, the business community and the community at large; and cost effectiveness.

I hope that the Dole Foundation's how-to manual, when we distribute it, will serve as a roadmap. In the meantime, funding organizations are often willing to provide information and advice on how to meet their requirements. In other cases, especially in the case of private funding sources and some government sources not specifically focused on vocational rehabilitation or technology, fund seekers may have to help the funding sources to broaden their horizons by educating them about the applicability and relevance of rehabilitation technology to their mission and goals. That brings us back full circle to the qualities of creativity, imagination, business sense, good communication skills, and the time-consuming but frequently rewarding work of tracking down those funding agencies who can be convinced that ***your*** program can help them achieve ***their*** mission.

[1] DeWitt, J.C., & Mendelsohn, S. (in progress). Funding assistive technology programs and organizations: Five case studies of success and innovation. Success and innovation in funding assistive technology programs and organizations: Issues, case studies and planning.

# Innovative Technology for People with Disabilities: What Can Be, What Is, And What Will Be

Sam McFarland

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I'd like to take you back to the future. How many people have seen the movie? I have something of my own version of that. I'd like to describe three or four rather innovative products that have been developed for use by people with disabilities. These are primarily people with physical disabilities, but I think you can translate the information to your own field of interest.

One product is a rather unique looking wheelchair. It has a device a paraplegic would use to allow movement from full squat position to full standing position with little hand cranks on the side to allow the individual to move around. Its implications for mobility at the worksite are obvious because we're all familiar with the difficulty of varying heights of work surfaces and things that need to be reached as this situation affects a person who is using a wheelchair.

Another product is a pair of bilateral upright long leg braces. Leg braces have been around since the early days of polio treatment. I don't think there is anything unfamiliar about them, except the ones I describe are made of graphite. They weigh about 15% as much as stainless steel and aluminum ones.

Envision this version of a control system--you're looking from the back of a van toward the dashboard, driver's seat on the left and steering wheel on the left--and just between you and the engine cover is a funny looking little T-handle stick which is the way the vehicle is driven, i.e., a single stick control, not unlike what you would use to operate a conventional electric wheelchair. It puts all the vehicle driving control into one hand, or both hands on the same stick, if you will. Push it forward, and it operates the throttle; tip it left and it turns left; tip it right and it turns right; pull back as you would on the reins in the horse and buggy days and it stops.

When I say back to the future, the reason I'm saying that is because all three of the products I just described were first implemented in 1972-73, and are only in clinical trials or just reaching the marketplace. If we're going to talk about where technology goes in the future, whether at the worksite, or getting you to the worksite, or enjoying your life when you're away from the worksite, or communicating back and forth between worksite and home, I think we have to stop and be a little bit concerned about the dissimilarity between what can be done, what is being done and what will be done. That's why I want to point out a couple of things that are having an effect on this.

The market, whether it is the perceived market or the documented market, for products to be used by people with disabilities is quite small. At least one of the products mentioned earlier may never be able to penetrate the market to be sold because nobody can come up with documentation that shows that there are enough paraplegics around who could use a wheelchair that operates at all levels. Now I say "perceived" market because we don't have market data. We don't yet have information that can make any kind of compelling argument for why a product should be produced in order to make a profit for the people who produce it.

When you come right down to it, if you're going to produce something and try to sell it, you're not doing that for an esoteric reason. It is a reality. It is that you want to recoup your cost as a minimum. If you are the manufacturer, producer, distributor, or vendor of a product, you've got to meet your expenses as a minimum, and you might even enjoy making a profit. So you need to know something about the size of the market, how many people could be affected by that, and how many of them can pay for it.

It's one thing to have 100,000 people who could use a wheelchair, but how many of those people can buy a $1600 wheelchair that, for all intents and purposes, looks the same as a $300 wheelchair to a lot of the reimbursement agencies? You can buy a wheelchair that has two large wheels in back and two casters up front, and a seat on it. It rolls, and it will go from one place to another. But we can question how well this all works with an occupant for a cost of $250-$300. You can also buy one that will accomplish the same thing much more efficiently, last longer, and be more reliable in many respects, for $1300 or $1400. The description is the same.

Description is what a lot of the reimbursement/payment agencies consider in making a choice. A wheelchair is a wheelchair, you know.

Let's buy the cheapest one! We have to educate the people who are responsible for making purchases of these technologies, i.e., the adaptive equipment. We have to educate them as to how to make an appropriate selection, what to look for, how to be an informed shopper. And then we have to get more and more of these products and technologies in use and ***prove*** what benefits there have been in using them.

If you consider the difference between spending $3200 for a powered wheelchair which gives an individual eight hours of independence during the day, and having that same individual in a wheelchair that he or she cannot propel, and need attendant care at X number of dollars per hour per day, it won't take long to come up with an argument for why one is better than the other on a cost-benefit basis. We, I speak for myself as being a technologist--we haven't won that war. We have not made a compelling argument to the payment agencies, be it Medicare, the Veterans Administration, private insurance, charitable organizations, or whatever, that money spent in the right place, at the right time, in the right way and in an informed manner will be money saved in the long run (if money is the only object and you throw away quality of life, productivity, and other things of that nature). These are some of the problem areas that we're really dealing with right now in trying to advance the technology that is readily available to us to apply to the needs of people with disabilities. We have some of these hurdles in front of us.

To deal with this issue, some of our professional societies are trying to gain recognition for people who ***know*** something about the technologies, who ***know*** something about the products, and who ***can*** make informed recommendations as to how to best select and apply a product. The rehabilitation engineering organization called RESNA, of which I am a member, and many of you may be members, is beginning to wrestle with the idea that, if we are going to get greater utilization and appropriate utilization of technology, we're going to have to be more professional about it. We're going to have to work with developing standards, work with developing education programs, be active on Capitol Hill, work individually with the payment resources, and come up with a much more professional approach to this field.

I am a rehabilitation engineer, and a member of a large group of people who are a "hoax." There really is no such thing as a rehabilitation engineer. You can't buy one, you can't hire one, you can't credential one; there are none being trained and educated in this country. And yet there are a lot of people who are very effectively applying technology to the needs of people with disabilities. But we don't have anybody in the world right now who can be officially recognized as a rehabilitation engineer, who can submit a bill to the insurance company and receive payment for his or her time.

So that's what our societies are working on--trying to get that kind of recognition, to certify who those people are, what they have to offer, make sure they're doing a good job, and following up on the products themselves. There are some neat products out there. There are also some horrible products out there. We have to sort through those and know how to choose the most appropriate product to apply to a given human being's needs.

Now let's talk about human beings for just a moment. Are we, in fact, giving that person proper recognition for his/her humanity while we, at the same time, try to apply our skills and technology, mechanisms and computers, voice recognition, and all the things that this individual may be using? Are we doing a good job of remembering there is a person there? We must take into consideration psychological factors of the user, of the payer, and of the associates of those individuals who are out in the world trying to lead their lives.

If we cannot design a product that is cosmetically pleasing, there is a high potential that the product will be abandoned even though it is doing a good job. And there is every reason to abandon a product that doesn't do a good job. If we don't have reliable products, we create dependency. If we give individuals the capability of eight hours of freedom a day in a powered wheelchair, they can send their attendants home and they go out into the world free to live their lives as they please. But if the damn thing stops in the middle of the street, they don't have freedom anymore. So we have to make sure that we are applying these technologies in a way that is appropriate to the needs of the human being. We must make sure that the product is reliable, has the right price, can be serviced by someone, and someone has helped make the appropriate decision in how to select it and apply it.

A lot of people are working on this in various places around the country. An example of one lab that is being set up is a motion analysis laboratory in a clinical setting in Iowa. We are attempting to get more accurate measurement of what these people are doing, with and without adaptation. With adaptation we want to be able to measure if we have been able to improve the performance of the individual in a quantitative sense. If not, why? Because that information is reproduceable, it's trackable, and it can be used for documentation. But best of all, if we can get to where we can accurately measure what people are doing, with and without technology, we can take full advantage of the geniuses of technology who are not currently working in rehabilitation.

If we can define a problem--not in clinical terms, not in user terms, not in pejorative terms, but in engineering terms--we can tap the engineering skill which already exists in this country. But we've got to get the information back to these people in terms that they understand. One of the biggest problems we've had for many years is that the products we're trying to foist off on people with disabilities were designed for one person, and then replicated out to the next 100. Or, they were designed by someone who was a rather decent engineer, but the thing was described in terms they didn't understand. So they had to make a hip pocket guess as to how this thing was to be used. In the high technology community, people really know that technology, but don't understand the problem.

Part of what we need to do, and what we are beginning to do, is to supply that information to those people. We need them to be able to accurately select and apply, and perhaps make minor modifications to technologies, so they appropriately suit the needs of an individual. The very best thing that we could do in the long haul would be to encourage the development of products and technologies that do not realize that the user of that technology is disabled. And then that person will no longer be disabled. If a computer can't see that the person who is operating it is blind, but if it gets the right signals, the computer will do the job. If the person who's operating the computer has cerebral palsy but can give the right kind of signals to the computer, the computer will do the job. I think we are moving in the direction to where the technologies we all live with will eventually fail to recognize that anyone is disabled, that there is just a human operator--thank you, sir, we'll do business with you today. We need to make the world more accessible, period. Not to disabled people, but to people.

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*Note:* Sam McFarland was the Director of the Rehabilitation Engineering Program at the National Rehabilitation Hospital when this original presentation was made. Mr. McFarland passed away after a short illness in June, 1989. In order to bring this article to publication, NRH Rehabilitation Engineering staff completed final editing. Every effort was made to remain true to Sam's principles and understanding of all that is being accomplished in this field and what the future holds. Sam was a firm believer in the composite approach to developing technology to enhance independence and empower persons with disabilities.

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**Gerald Weisman** is the Director of Rehabilitation Engineering and a Research Project Director at the Vermont Rehabilitation Engineering Center for Low Back Pain. Mr. Weisman, who holds a Masters degree in Mechanical Engineering from the University of Vermont, has worked in the field of rehabilitation engineering for 13 years. Previous positions have included Clinical Engineer at the Veterans' Administration Prosthesis Center in New York, Director of Rehabilitation Engineering at Crotched Mountain Rehabilitation Center in New Hampshire, and owner of a private rehabilitation engineering firm. He has published numerous articles on rehabilitation engineering, particularly as it applies to the workplace, on occupational low back pain and disability, and on rehabilitation technology service delivery. Mr. Weisman was recently named a Switzer Scholar in recognition of his work in the field of rehabilitation engineering in the workplace.

**Jeanne Argoff** is Director of the Grants Program at The Dole Foundation for the Employment of People with Disabilities. Before joining the Foundation, Dr. Argoff was a research consultant with the U.S. Congress' Office of Technology Assessment, and with private research firms like Technology Research Corporation and Westat, Inc. She has taught at George Mason University and has been manager of publications and research for the National Alliance of Business' Information Clearinghouse for Employment and Training Issues. Her M.A. is from the University of California at Berkeley and her Ph.D. is from University College, Dublin, Ireland.

**The President's Committee on Employment of People with Disabilities** was established by President Truman in 1947. The Committee's purpose is to promote a positive climate of opinion in America leading to full acceptance of physically and mentally disabled people in the world of work, and to strive to mobilize the nation's resources, both public and private, to achieve this end. All achievements of the Committee are the result of combined efforts of some 600 voluntary organizations and community leaders from all segments of the American population. These members include representatives from civic organizations, veterans groups, the professions, and people with disabilities. The Chair of the Committee is Mr. Justin Dart and the Executive Director is Mr. Jay Rochlin.

**The Arkansas Research and Training Center in Vocational Rehabilitation** was established at the University of Arkansas in 1965. Funded through a grant from the National Institute on Disability and Rehabilitation Research, the Center has an extensive history in research and training in rehabilitation and disability-related issues. Currently, the Center is conducting research on employability assessment, return to work for mid-career disability onset, independent living and vocational programming, peer counseling and employment, and the employment preparation needs of youth and adults with disabilities. In addition, the Center serves as a host for the Institute on Rehabilitation Issues, a national study group that conducts and publishes a study on topics of national significance to the rehabilitation community.

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